

**REMARKS**

In view of the above amendments and the following remarks, reconsideration of the rejections contained in the Office Action of May 13, 2008 is respectfully requested.

By this Amendment, claims 1, 5 and 8 have been amended, and new claims 9 and 10 have been added. Thus, claims 1, 4, 5 and 8-10 are currently pending in the application. No new matter has been added by these amendments.

Revisions have been made to the specification, as identified above. It is noted that support for the amendments to the specification can be found at page 12, lines 18-25 of the original specification. No new matter has been added by the revisions. Entry of the amendments to the specification is thus respectfully requested.

On pages 3-6 of the Office Action, the Examiner rejected claims 1, 4, 5 and 8 under 35 U.S.C. § 103(a) as being unpatentable over Borsboom et al. (US 4,981,661) in view of Srinivas et al. (US 6,099,819) and Forg et al. (US 5,660,807). For the reasons discussed below, it is respectfully submitted that the amended claims are clearly patentable over the prior art of record.

Amended independent claim 1 recites a COS treatment apparatus for a gasified gas containing  $\text{H}_2\text{S}$ ,  $\text{H}_2\text{O}$ ,  $\text{O}_2$ , and  $\text{CO}$ . The COS treatment apparatus of claim 1 includes a first reactor into which the gasified gas is to be introduced, with the gas having a temperature of at least  $300^\circ\text{C}$ , and a second reactor located at a downstream side of a gasified gas flow with respect to the first reactor. Claim 1 also recites that the first reactor comprises an  $\text{O}_2$  removal catalyst for accelerating the following reaction:  $2\text{H}_2\text{S} + 2\text{CO} + \text{O}_2 \rightarrow 2\text{COS} + 2\text{H}_2\text{O}$ , with the  $\text{O}_2$  removal catalyst being a  $\text{TiO}_2$  catalyst carrying  $\text{Cr}_2\text{O}_3$  or  $\text{NiO}$ . Further, claim 1 recites that the second reactor comprises a COS conversion catalyst.

Amended independent claim 5 recites a COS treatment method for a gasified gas containing  $\text{H}_2\text{S}$ ,  $\text{H}_2\text{O}$ ,  $\text{O}_2$ , and  $\text{CO}$ . The method of claim 5 includes removing  $\text{O}_2$  from the gas by using a  $\text{TiO}_2$  catalyst carrying  $\text{Cr}_2\text{O}_3$  or  $\text{NiO}$  at a gas temperature of at least  $300^\circ\text{C}$  to accelerate the following reaction:  $2\text{H}_2\text{S} + 2\text{CO} + \text{O}_2 \rightarrow 2\text{COS} + 2\text{H}_2\text{O}$ . The method of claim 5 also includes, after the removing of  $\text{O}_2$  from the gas, converting COS contained in the gas to  $\text{H}_2\text{S}$  by using a COS conversion catalyst.

Borsboom discloses a process for removing sulfur compounds from a CO containing gas.

In particular, Borsboom discloses that  $O_2$  is removed from a gasified gas by the hydrogenation of  $O_2$  under a Co-Mo catalyst prior to the hydrolysis of COS. Borsboom also discloses that the hydrogenation of  $O_2$  occurs in accordance with the following reaction:  $0.5O_2 + H_2 \rightarrow H_2O + \text{heat}$  (Equation (6) of Borsboom).

However, as noted by the Examiner on page 3 of the Office Action, Borsboom does not disclose that *an  $O_2$  removal catalyst is a  $TiO_2$  catalyst carrying  $Cr_2O_3$  or  $NiO$* , as required by independent claims 1 and 5. Accordingly, it is respectfully submitted that independent claims 1 and 5 are not anticipated by Borsboom.

Srinivas discloses catalysts for the selective oxidation of hydrogen sulfide. In particular, Srinivas discloses a catalyst which includes a mixture of  $TiO_2$  and one or more oxides of a group of metals which includes Cr and Ni. Srinivas discloses that the catalyst is used for selectively oxidizing hydrogen sulfide according to the following reaction:  $H_2S + 0.5O_2 \rightarrow H_2O + S$  (Equation (1) of Srinivas).

On page 3 of the Office Action, the Examiner asserts that Srinivas discloses that a  $TiO_2$  catalyst carrying  $Cr_2O_3$  or  $NiO$  is an  $O_2$  removal catalyst, and therefore concludes that it would have been obvious to one of ordinary skill in the art to use the catalyst with the teachings of Borsboom to arrive at the present invention. However, Srinivas does not disclose or suggest that a  $TiO_2$  catalyst carrying  $Cr_2O_3$  or  $NiO$  is an  $O_2$  removal catalyst. Rather, Srinivas discloses that the catalyst selectively oxidizes hydrogen sulfide into sulfur and water, as shown in Equation (1) of Srinivas. In other words, Srinivas discloses a catalyst which produces sulfur and water, and does not disclose an  $O_2$  removal catalyst, as required by independent claims 1 and 5.

Further, it is noted that Borsboom discloses that the oxidation of hydrogen sulfide into sulfur is problematic because the resulting sulfur will solidify and cause clogging when the gas is cooled (column 2, lines 19-26). Thus, as Srinivas only discloses a catalyst for oxidizing hydrogen sulfide into sulfur, it would not have been obvious to one of ordinary skill in the art to use the catalyst of Srinivas with the apparatus of Borsboom, because Borsboom expressly teaches away from oxidizing hydrogen sulfide into sulfur.

Forg discloses a process for the removal of HCN from gas mixtures. In particular, Forg discloses a catalyst including titanium dioxide and chromium for decomposing HCN and COS.

However, Forg does not disclose *an O<sub>2</sub> removal catalyst for accelerating a reaction of 2H<sub>2</sub>S + 2CO + O<sub>2</sub> → 2COS + 2H<sub>2</sub>O at a temperature of at least 300°C*, as required by independent claims 1 and 5. Rather, Forg only discloses a catalyst for decomposing HCN and COS at temperatures of 130°C to 250°C.

Therefore, for the reasons presented above, it is believed apparent that the present invention as recited in independent claims 1 and 5 is not disclosed or suggested by the Borsboom reference, the Srinivas reference and the Forg reference taken either individually or in combination. Accordingly, a person having ordinary skill in the art would clearly not have modified the Borsboom reference in view of the Srinivas reference and the Forg reference in such a manner as to result in or otherwise render obvious the present invention of independent claims 1 and 5.

Independent claim 9 recites a COS treatment apparatus for a gasified gas containing H<sub>2</sub>S, H<sub>2</sub>O, O<sub>2</sub>, and CO. The treatment apparatus of claim 9 includes a reactor into which the gasified gas is to be introduced, with the reactor comprising a TiO<sub>2</sub> catalyst carrying Cr<sub>2</sub>O<sub>3</sub> and BaO. Claim 9 also recites that the TiO<sub>2</sub> catalyst carrying Cr<sub>2</sub>O<sub>3</sub> and BaO is an O<sub>2</sub> removal catalyst for accelerating the following reaction:  $2\text{H}_2\text{S} + 2\text{CO} + \text{O}_2 \rightarrow 2\text{COS} + 2\text{H}_2\text{O}$ , and that the TiO<sub>2</sub> catalyst carrying Cr<sub>2</sub>O<sub>3</sub> and BaO is a COS conversion catalyst.

Independent claim 10 recites a COS treatment method for a gasified gas containing H<sub>2</sub>S, H<sub>2</sub>O, O<sub>2</sub>, and CO. The method of claim 10 includes removing O<sub>2</sub> from the gas by using a TiO<sub>2</sub> catalyst carrying Cr<sub>2</sub>O<sub>3</sub> and BaO to accelerate the following reaction:  $2\text{H}_2\text{S} + 2\text{CO} + \text{O}_2 \rightarrow 2\text{COS} + 2\text{H}_2\text{O}$ . The method of claim 10 also includes simultaneously converting COS to H<sub>2</sub>S by using the TiO<sub>2</sub> catalyst carrying Cr<sub>2</sub>O<sub>3</sub> and BaO.

It is noted that none of the Borsboom, Srinivas and Forg references discloses *a reactor comprising a TiO<sub>2</sub> catalyst carrying Cr<sub>2</sub>O<sub>3</sub> and BaO, wherein the catalyst an O<sub>2</sub> removal catalyst for accelerating the following reaction: 2H<sub>2</sub>S + 2CO + O<sub>2</sub> → 2COS + 2H<sub>2</sub>O, and wherein the catalyst is a COS conversion catalyst*, as required by independent claim 9. Similarly, none of the Borsboom, Srinivas and Forg references discloses includes a method which includes *removing O<sub>2</sub> from the gas by using a TiO<sub>2</sub> catalyst carrying Cr<sub>2</sub>O<sub>3</sub> and BaO to accelerate the following*

*reaction:  $2H_2S + 2CO + O_2 \rightarrow 2COS + 2H_2O$ , and simultaneously converting COS to  $H_2S$  by using the  $TiO_2$  catalyst carrying  $Cr_2O_3$  and  $BaO$ , as required by independent claim 10.*

Therefore, for the reasons presented above, it is believed apparent that the present invention as recited in independent claims 9 and 10 is not disclosed or suggested by the Borsboom reference, the Srinivas reference and the Forg reference taken either individually or in combination. Accordingly, a person having ordinary skill in the art would clearly not have modified the Borsboom reference in view of the Srinivas reference and the Forg reference in such a manner as to result in or otherwise render obvious the present invention of independent claims 9 and 10.

In addition, the Examiner's attention is directed to the dependent claims which further define the present invention over the prior art. In particular, dependent claim 4 recites that *the  $O_2$  removal catalyst is located in a higher-temperature region with respect to the COS conversion catalyst*. Similarly, dependent claim 8 recites that *the removing  $O_2$  from the gas is performed at a higher temperature with respect to the converting COS to  $H_2S$* . In this regard, on pages 4 and 6 of the Office Action, the Examiner indicates that column 2, lines 39-55 of Borsboom discloses that the  $O_2$  removal catalyst is located in a higher-temperature region than the COS conversion catalyst.

However, it is noted that the section of Borsboom cited by the Examiner (*i.e.*, column 2, lines 39-55) discloses a process which includes "(a) a first stage comprising converting a portion of the CO present with water in the presence of a catalyst with simultaneous or subsequent hydrogenation of any  $O_2$ ," and "(b) a second stage comprising catalytically hydrolyzing COS." Further, the section of Borsboom cited by the Examiner (*i.e.*, column 2, lines 39-55) discloses that the catalytic conversion of the CO in stage (a) produces heat which can raise the temperature of the gas to the value required for the second stage. In other words, Borsboom discloses that the gas has a lower temperature at the first stage, and is heated up to the required temperature of the second stage.

More specifically, it is noted that Borsboom discloses that the temperature of the gas supplied to the first stage (*i.e.*, the  $O_2$  removal stage) is at least  $200^\circ\text{C}$ , and that the feed of the

second stage will be at least 25° C hotter than the feed in the first stage (see column 4, lines 37-41). Therefore, Borsboom does not disclose that the O<sub>2</sub> removal catalyst is located in a higher-temperature region with respect to the COS conversion catalyst, as required by dependent claims 4 and 8, because Borsboom discloses that the O<sub>2</sub> removal stage occurs at a *lower* temperature than that of the second stage.

Therefore, it is respectfully submitted that independent claims 1, 5, 9 and 10, as well as claims 4 and 8 which depend therefrom, are clearly allowable over the prior art of record.

In view of the foregoing amendments and remarks, it is respectfully submitted that the present application is clearly in condition for allowance. An early notice to that effect is respectfully solicited.

If, after reviewing this Amendment, the Examiner feels there are any issues remaining which must be resolved before the application can be passed to issue, the Examiner is respectfully requested to contact the undersigned by telephone in order to resolve such issues.

Respectfully submitted,

Masahiro HARADA et al.

By: 

Walter C. Pledger

Registration No. 55,540

Attorney for Applicants

WCP/lkd  
Washington, D.C. 20006-1021  
Telephone (202) 721-8200  
Facsimile (202) 721-8250  
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